# NCV7681LGEVB

# NCV7681LGEVB Evaluation Board User's Manual

## Eight (8) Channel Enhanced 100 mA Linear Current Regulator and Controller for Automotive LED Lighting Evaluation Board User's Manual

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**EVAL BOARD USER'S MANUAL**

### Description

The NCV7681L is an octal LED driver designed for automotive LED car rear combination lamps. External programmability of the NCV7681L allows the user to set the tail current and stop currents using a single resistor for each function.

A one-out all-out function disable all strings when an open circuit occurs on one string.

Systems not requiring one-out all-out have the option of using the NCV7681A.

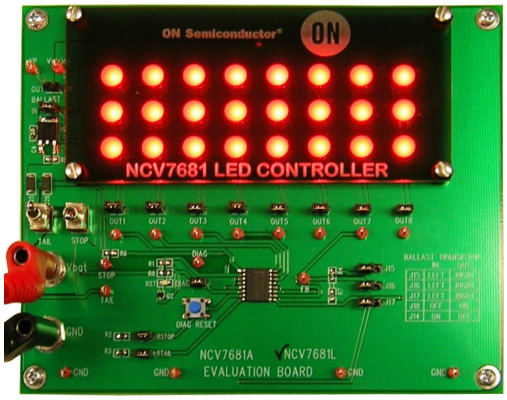
The two typical control inputs into the system are available through on-board switches or through the pin connections to external controls. The two system control inputs are the STOP and TAIL functions. The STOP function displays a 100% duty cycle current through the LEDs. The TAIL function displays a programmable PWM current through the LEDs.

### Features

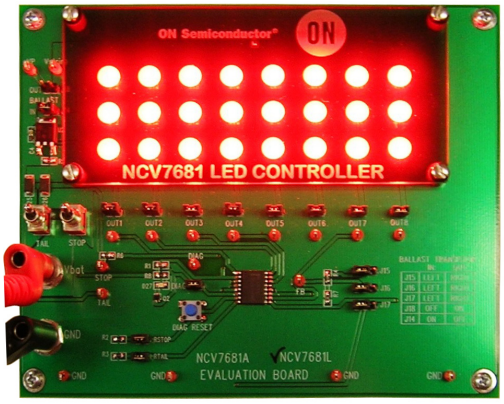
- One Out, All Out (Latch Off) Optional Functionality
- STOP, TAIL (100% Duty Cycle, PWM) Modes
- Flexibility for
  - External LED Connections
  - LED Current Programmability (RSTOP)
  - LED PWM Programmability (RTAIL)
  - STOP, TAIL External Connections
  - External DIAG Pin Connection

### Application

The NCV7681L features the ability to drive 8 individual strings of LEDs (reference Figure 2) with a programmed current for a DC current for STOP mode and a PWM current for TAIL model. These are programmed using resistors to ground on the RSTOP and RTAIL pins. Control of the STOP and TAIL functions use an external network of diodes with the STOP pin. LED open string reporting is reported on the DIAG pin. The DIAG pin also serves to reset a latched off event. System power distribution is accomplished using voltage feedback on the top LED anode programming a set voltage in the system to allow a split between the IC and the ballast transistor.




**TAIL Mode**




**STOP Mode**

**Figure 1. Evaluation Board Picture**

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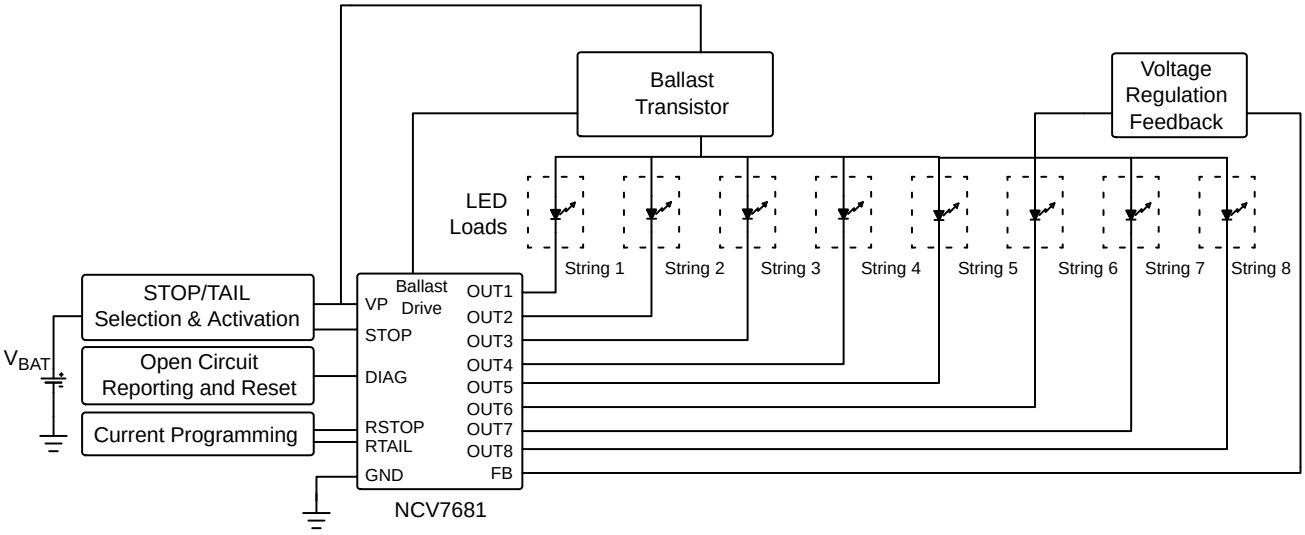


**Figure 2. Focus Demonstration**

**STOP**

The STOP function displays the highest system output current at 100% duty cycle. Using the STOP switch activates this function. The current is programmable with a resistor on the RSTOP pin to ground. Jumper J3 provides isolation of pin 7 of the NCV7681 allowing access to the pin for alterative selection of output current. The range of programmability is from 15 mA to 100 mA using the equation:

$$I_{OUT} = \frac{150}{RSTOP}$$

where RSTOP is the resistor value.

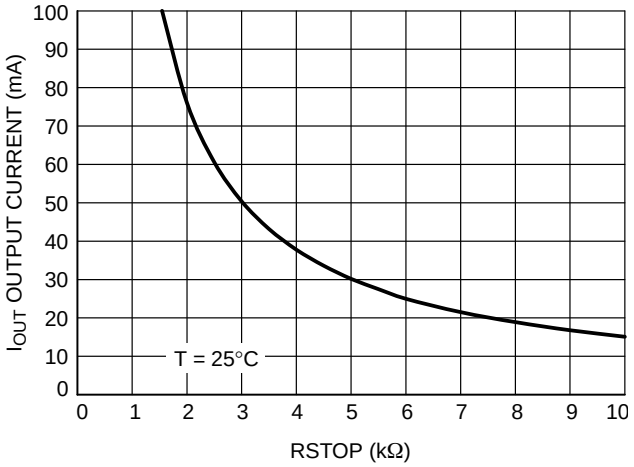


**Figure 3. $I_{OUT}$ vs. RSTOP**

**TAIL**

The TAIL function displays a lower equivalent output current in the system. This provides a lower illumination of the LEDs. This is achieved with a varied duty cycle of the output current. The duty cycle is programmable with a resistor on the RTAIL pin to ground. Jumper J4 provides isolation of pin 6 of the NCV7681L allowing access to the pin for alternative selection of output duty cycle current. The range of programmability is from 0% duty cycle to 100% duty cycle using the equation:

$$RTAIL = 1.8 \times RSTOP\ (DC + 0.22)$$

where DC = duty cycle expressed in fractional form.

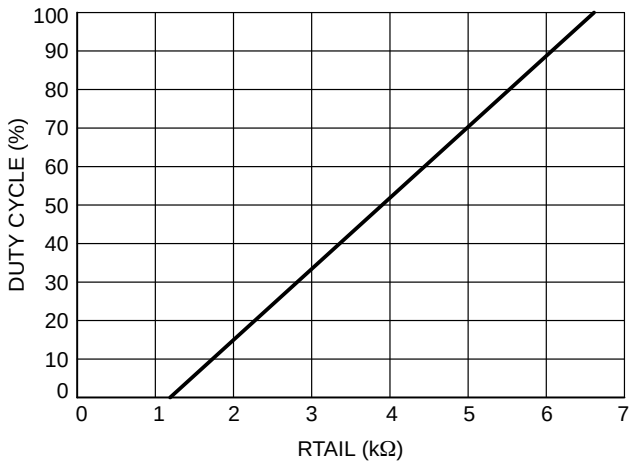


**Figure 4. Duty Cycle vs. RTAIL**

### Latch Off (“One-Out, All-Out”)

To improve user aesthetics, the system design utilizes the Latch Off function. All outputs will become latched off when any one of the 8 outputs experiences an open circuit condition. This is defined (at 50 mA) in the electrical parameter “Open Circuit Detection Threshold” and has limits between 35% and 65% of the output current. DIAG RESET switch SW3 provides a system refresh by temporarily grounding the DIAG pin.

### DIAG

The DIAG pin of the NCV7681L provides system feedback for conditions:

1. Output open circuit.
2. Set Back Current Limit down 20%.
3. Thermal shutdown.
4. RSTOP Current Limit.

An LED indicator with a current setting resistor provides illumination of these conditions. Jumper J5 provides access to these pins for the user to use off-board.

### External LEDs

The NCV7681LGEVB is compatible for use with external LEDs.

To use external LEDs,

1. Remove J14 or J18 depending on your setup
2. Replace with the Anode of your external LED string (connect to the post on the right).
3. If needed, connect the post on the left also with the anode of your external LED string.
4. Remove your selection of J6−J13 (OUTx,y).
5. Connect the Cathode of your external LED string (connect to the post on the right).

The operation of the NCV7681L evaluation board works as a standalone presentation for the customer. Jumpers are provided for flexibility of customer specific designs with external LEDs and programming of the current and duty cycle. External control points are also provided in addition to the on-board control switches. The user must adhere to the absolute maximum ratings when using off-board connections.

Note the inclusion of the Open Load Disable Threshold in the NCV7681L device. This is included to avoid false open load detection at low supply voltages due to headroom issues with external LEDs. Operation of LED drive current is valid above the Output Under Voltage Lockout threshold ($V_P$ = 4.1 V [typ]), allowing for illumination down to that voltage, but open load detection is only valid above $V_P$ = 7.7 V [typ].

**Table 1. ABSOLUTE MAXIMUM RATINGS**

| Rating | Value | Unit |
|---|---|---|
| Supply Voltage to board ($V_{BAT}$) | −40 to 40 | V |
| STOP, TAIL | −40 to 40 | V |
| LED Current Source (OUT1−OUT8) | 200 | mA |
| Output Pin Voltage (OUT1−OUT8) | −0.3 to 40 | V |
| Output Pin Voltage (RTAIL, RSTOP) | −0.3 to 3.6 | V |
| DIAG | −0.3 to 40 | V |
| $V_{STRING}$ | −0.3 to 40 | V |
| Junction Temperature (NCV7681L) | −40 to 150 | °C |
| Junction Temperature (Evaluation Board) | −40 to 105 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**Table 2. RECOMMENDED BOARD OPERATING CONDITIONS**

| Rating | Value | | Unit |
|---|---|---|---|
| | Min | Max | |
| External Supply Voltage ($V_{BAT}$) | − | 28 | V |
| LED Current Source | − | 200 | mA |
| Junction Temperature (NCV7681L) | −40 | 150 | °C |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

**Table 3. PIN FUNCTION DESCRIPTION**

| Connector | Pin Number | Terminal Name | Description |
|---|---|---|---|
| Power | J1, $V_{BAT}$ | $V_{BAT}$ | Power Supply Input Voltage (14 V) |
| | J2, GND | GND | Ground |
| | J3 | RSTOP | Programmable DC Current |
| | J4 | RTAIL | Programmable Duty Cycle |
| | J5 | DIAG | DIAG Open Drain Output and Open Circuit Reset Input |
| | J6<br>J7<br>J8<br>J9<br>J10<br>J11<br>J12<br>J13 | OUT1<br>OUT2<br>OUT3<br>OUT4<br>OUT5<br>OUT6<br>OUT7<br>OUT8 | Current Outputs |
| | J14 | BALLAST IN | Connect when Using External Ballast Transistor.<br>Connects Drain of External Ballast Transistor to $V_{STRING}$. |
| | J15 | J15 | Connection to Top of the FB Resistor Network or Open Circuit |
| | J16 | J16 | Connection to Short FB Pin to Ground or Open Circuit |
| | J17 | J17 | Connection for Ballast Drive Gate Pin to Ballast Gate or to Ground |
| | J18 | BALLAST OUT | Connect when Not Using External Ballast Transistor. Shorts S-D of External Transistor. |

### User Interface Locations

Figure 5 shows all the user interface locations.

This lists all the user options available on the evaluation board.

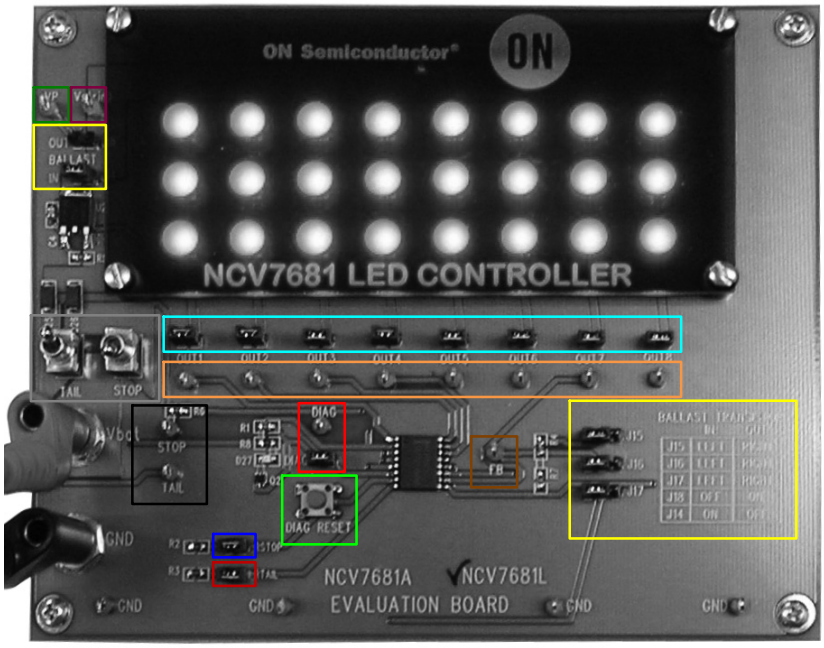


**Figure 5. User Interface Locations**

Black − STOP, TAIL external connections.

Grey – STOP, TAIL switches.

Dark Blue (2) – STOP programming jumper.

Red (2) – TAIL programming jumper + post.

Dark Green – VP post.

Purple (2) – $V_{STRING}$ post.

Light Blue (4) – OUT1−OUT8 open circuit jumpers.

Orange − OUT1−OUT8 output posts.

Yellow – Ballast Transistor Selection (2 yellow boxes).

Light Green – DIAG RESET.

Bright Red – DIAG jumper / post.

Brown – Feedback post (FB).

## OPERATIONAL GUIDELINES

The material necessary to successfully use the evaluation board is listed below.

- NCV7683 Evaluation Board
- 14 V Power Supply Capable of drive 1 A.

### Configure the Board

*Typical Board Configuration with On-Board Components*

1. Connect all jumpers on the board with the exception of Jumper 18.
   J15−J17 should be to the left.
2. Connect the 14 V power supply.
3. Turn on the power supply.

*Increasing the LED Current*

Change the current programming resistor.
Reference the STOP section.

*Change the Duty Cycle*

Change the duty cycle programming resistor.
Reference the TAIL section.

*Latch Off*

After creating an open circuit and replacing all open circuit jumpers (OUT6−OUT8), press the DIAG RESET switch.

*DIAG*

The on-board LED will illuminate when DIAG reports a fault.
Reporting can be taken off-board after removing the DIAG jumper (J5).

*Use External LEDs*

Reference the External LEDs section for instructions.

## SCHEMATIC

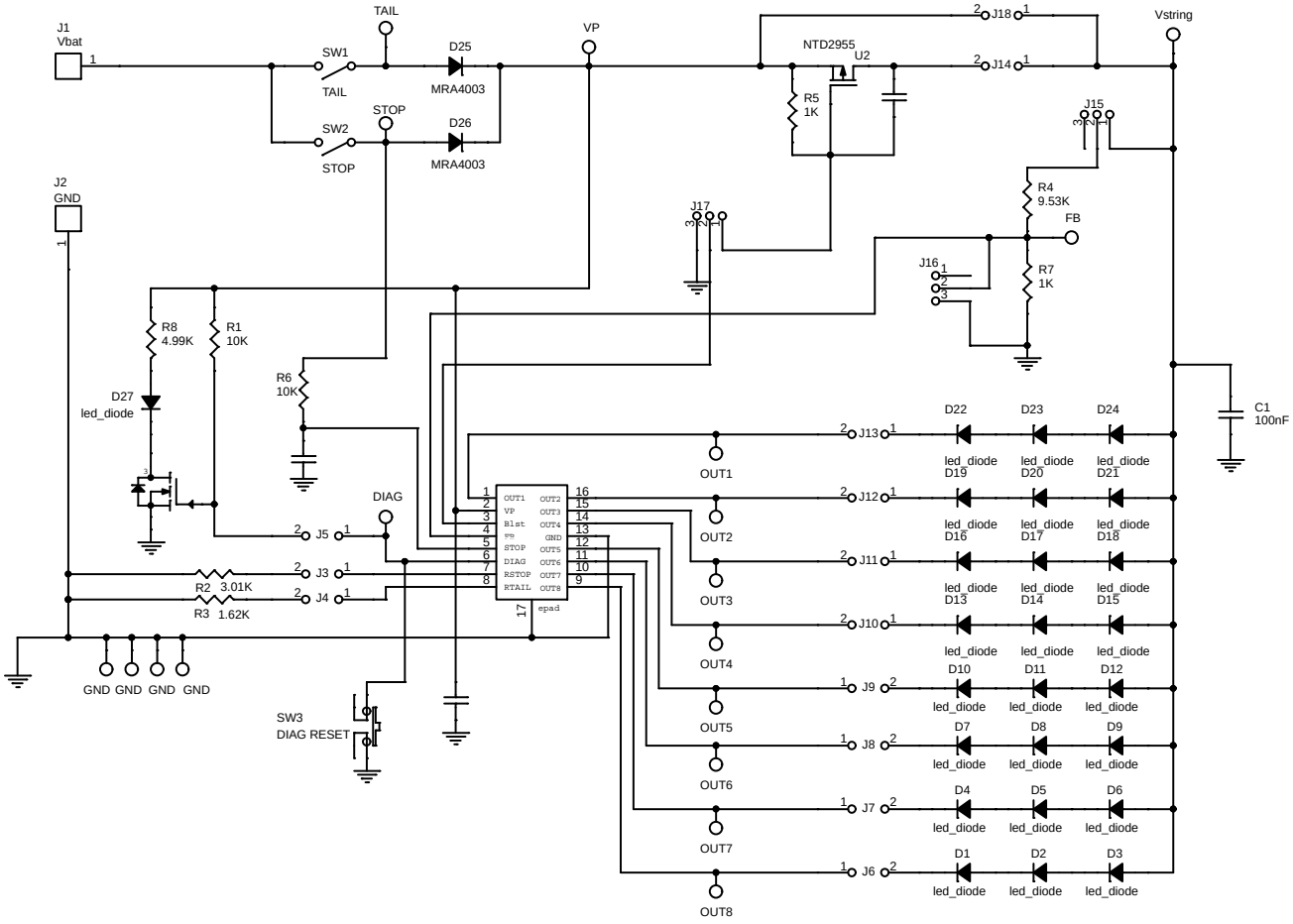


**Figure 6. Evaluation Board Schematic**

## BILL OF MATERIALS

### Table 4. NCV7681L LATCH OFF EVALUATION BOARD BILL OF MATERIALS

| Designator | Qty | Description | Value | Toler-ance | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed |
|---|---|---|---|---|---|---|---|---|
| C1 | 1 | LED Storage Capacitor | 100 nF | 10% | 0805 | KEMET | C0805C104K5RACTU | Yes |
| C2 | 1 | Debounce Capacitor | 10 nF | 10% | 0805 | KEMET | C0805C103K5RACTU | Yes |
| C3 | 1 | Input Capacitor | 0.68 μF | 10% | 0805 | KEMET | C0805C684K5RACTU | Yes |
| C4 | 1 | Loop Stabilization Capacitor | 0.22 μF | 10% | 0805 | KEMET | C0805C224K5RACTU | Yes |
| D1−D24 | 24 | Display LEDs | led_diode | − | G6SP | OSRAM | LRG6SP−CADB−1−1 | Yes |
| D25−D26 | 2 | Steering Diode | MRA4003 | − | SMA_DIODE | ON SEMICONDUCTOR | MRA4003T3G | Yes |
| D27 | 1 | DIAG Reporting LED | led_diode | − | 0805 | LITE−ON INC | LTST−C171GKT | Yes |
| J3−J14, J18 | 13 | Dual Jumper Posts 100 mil spacing | JUMPER | − | JMP | 3M | 961102−6404−AR | Yes |
| J15−J17 | 3 | Triple Jumper Posts 100 mil spacing | JUMPER | − | JMP | 3M | 961102−6404−AR | Yes |
| J3−J18 | 16 | Jumper | − | − | N/A | SULLINS CONNECTOR SOLUTIONS | QPC02SXGN−RC | Yes |
| J1 | 1 | Banana Jack | $V_{BAT}$ | − | BANANA | CINCH CONNECTIVITY SOLUTIONS | 108−0740−001 | Yes |
| J2 | 1 | Banana Jack | GND | − | BANANA | CINCH CONNECTIVITY SOLUTIONS | 108−0740−001 | Yes |
| Q2 | 1 | DIAG Illumination Transistor Switch | 2N7002W | − | SOT23M4 | ON SEMICONDUCTOR | ONC 2N7002WT1G/BKN | Yes |
| R1, R6 | 2 | Logic Resistors | 10 kΩ | 1% | 0805 | VISHAY DALE | CRCW080510K0FKEA | Yes |
| R2 | 1 | RSTOP Program Resistor | 3.01 kΩ | 1% | 0805 | VISHAY DALE | CRCW08053K01FKEA | Yes |
| R3 | 1 | RTAIL Program Resistor | 1.62 kΩ | 1% | 0805 | VISHAY DALE | CRCW08051K62FKEA | Yes |
| R4 | 1 | Vstring Program Resistor | 9.53 kΩ | 1% | 0805 | VISHAY DALE | CRCW08059K53FKEA | Yes |
| R5 | 1 | Gate−source Resistor | 1 kΩ | 1% | 0805 | VISHAY DALE | CRCW08051K00FKEA | Yes |
| R7 | 1 | Vstring Program Resistor | 1 kΩ | 1% | 0805 | VISHAY DALE | CRCW08051K00FKEA | Yes |
| R8 | 1 | DIAG LED Current Setting Resistor | 4.99 kΩ | 1% | 0805 | VISHAY DALE | CRCW08054K99FKEA | Yes |
| SW1, SW2 | 2 | User Interface Switches | − | − | MINITOGGLE | C & K COMPONENTS | T101MH9CBE | Yes |
| SW3 | 1 | SPST−NO 0.05A 24V Tactile Switch | − | − | 6x6 | TE Connectivity Alcoswitch | 1−1825910−0 | Yes |
| TP1−TP18, TAIL | 18 | Test Inputs | − | − | TP | KEYSTONE ELECTRONICS | 5010 | Yes |
| U1 | 1 | NCV7681L (SOIC−16WB epad) | − | − | 16WEPAD | ON SEMICONDUCTOR | NCV7681LPWR2G | No |
| U2 | 1 | NVD2955 | − | − | DPAK3_SMD | ON SEMICONDUCTOR | NVD2955T4G | No |

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